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of Ashland, and whose apex is in the northern part of Kingman county, than was given in the lecture of the preceding evening. He also inferred from the borings at Salina, Ellsworth and Russell, that the triangular form was continued in the subterranean development of the red-beds, and that Ellsworth was within, but near the apex of it. The main feature of the paper, in which its scientific bearing is of great importance, was the statement, also made in the lecture of the previous evening, that the saliferous shales and beds of rock salt which lie beneath the Triassic red-beds were continuous downward with them, and also were continued down without break into the Permo-Carboniferous formations. That is, that in southern Kansas — and presumably in the Indian country beyond — there is no break from Paleozoic to Mezozoic time.

This is not abtolutely affirmed, but the writer believes that the great mass of the evidence so far tends that way.

NOTE.— Just before this goes to press, the writer has made other observations in Kingman and Sumner counties, and finds outcrop of the red-beds six miles west of Wellington, and the proof more positive that they are continuous with the grayer shales below, and that these shales, extending to and beyond Wellington, all belong to the saliferous horizon.— R. H.

THE LOGAN COUNTY NICKEL MINES.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

While engaged in collecting specimens of Natural History in Wallace and Logan counties in August, 1888, I learned that considerable excitement had been produced in the central portion of the latter county by the discovery of valuable metallic ores. The first reports specified silver as occurring in paying quantities in that region, but later advices substituted nickel for silver, without any abatement of the popular excitement. I lost little time in making my way to the scene of commotion, and found the center of the new mining region in the southwest quarter of section 2, township 14, range 46, west of the 6th principal meridian. This quarter-section is three miles south of the Smoky Hill river, eight and one-half miles distant from Russell Springs, the county seat of Logan county, fifteen miles a little west of south from Winona, and eighteen miles a little south of east from Wallace, the county seat of Wallace county. It is about forty-five miles east of the western boundary, and seventy-five miles south of the northern boundary of the State of Kansas. Upon reaching this locality, I found that although less than two weeks had elapsed since the announcement was first made of the discovery of these mineral deposits, more than 400 acres of ground had been staked off for mining claims, and the excitement was becoming more intense every day. Hundreds of people were coming and going, and the once peaceful prairie had suddenly assumed the boisterous character of a genuine mining camp. The nomenclature of the claims indicates that Kansas can vie with Colorado and Arizona in the use of expressive language. The following are the names by which some of the prospect holes have been christened: Western Chief, Nickel King, Nickel Queen, Eli, Jimmie, Eureka, Nickel Cañon, etc..

Values of these mining claims had not found a definite basis; $20,000 was reported to have been offered and refused for the two best claims, and five hundred dollars had been indignantly rejected for a half-interest in a less promising mine.

I was especially interested in visiting this spot because in former years, in company with Professor Mudge, and subsequently with parties of University students, I had explored the rocks in the immediate vicinity in search of vertebrate fossils. It was within twenty-five miles of this locality that in 1878 I had the good fortune to discover the now famous saurian, whose remains are so perfectly preserved that even the dermal scales upon the abdomen are as accurately outlined as are those of living reptiles. Only six miles north of this spot we obtained during the same vacation a saurian whose jaws, nearly three feet in length, were just protruding from the blue shale, under such circumstances as to indicate that there had been no serious disturbance of the rock-strata during the millions of years which must have elapsed since the reptile gave up its life. It was within a few miles of this spot that Professor Mudge obtained the most perfect specimens of fossil birds which have ever been discovered; birds with teeth in their jaws, which have furnished the material for the great work on Toothed Birds (*Odontornithes*) by Prof. Marsh of Yale College. Having been thus familiar with this region as a paradise for fossil hunters, I was anxious to ascertain if it were possible that some local disturbance had produced metamorphic changes resulting in the formation of metallic ores. In Woodson county a square mile of the carboniferous rocks has thus been metamorphosed to an unknown depth, the disturbing forces having transformed into crystalline rocks the original fragmentary rocks, thus producing some of the conditions under which metallic deposits are found in mountainous regions. A great silver excitement was produced in that country about twelve years ago, having for its center this limited area of crystalline rocks. The chemists found faint traces of silver in their analysis of this material, and the entire area was honeycombed by the excavations of prospectors and miners, who gathered from near and from far, with the expectation of striking a bonanza. Thousands of dollars were expended in the vain attempt to extract the precious metals from rocks which had been declared by our best geologists and chemists to be of no actual value for mining purposes. It is true that a trace of silver was detected in these rocks. There are also traces of silver and gold in the waters of the ocean, and we are told that the total amount of these precious metals thus held in solution would be sufficient to make every human being rich if they could be separated from the containing waters by some inexpensive process. There are undoubtedly minute quantities of gold and silver in all our Kansas rocks, from the sub-carboniferous deposits of the southeast to the tertiary deposits of the northwest. A Denver chemist reported a trace of gold and a small amount of silver ($2.50 to the ton) in the rocks of Logan county. But any attempt to extract these metals from Kansas rocks seems as impracticable as would be the attempt to separate them from the waters of the ocean.

A careful examination of the rocks now being mined for nickel in Logan county reveals no evidence of metamorphic action. There is an entire absence of crystalline rocks. The so-called "nickel ore" is the prevailing fragmental rock of the Tertiary age, the characteristic conglomerate or pudding-stone which overlies the eroded surface of the Niobrara limestones and shales. The color of this rock at the "mines" is darker than that of the ordinary conglomerate, but it is unmistakably the same kind of rock. A chemical analysis of specimens of these rocks by Prof. E. H. S. Bailey reveals the presence of nickel and cobalt in very small quantities. A special examination of one specimen, said to be among the richest, showed not more than one-third of one per cent. of cobalt, and one-tenth of one per cent. of nickel. The specimens used for this analysis were of my own selection from the two mines considered to produce the most valuable ore.

It may be here stated that the lowest grade of nickel ore as yet found profitable for treatment is mined in large quantities at Lancaster Gap, Penn., and contains from 1½ to 2 per cent. of nickel. But this ore, in order to merit transportation to the refining works at Camden, N. J., must first be reduced at the mines to a more concentrated form by being smelted into a "matte" containing 10 per cent. of nickel. Thus the Logan county rocks, according to Prof. E. H. S. Bailey's analysis, contain only from one-fifteenth to one-twentieth the amount of nickel present in the lowest grade ores yet subjected to profitable treatment.

I made a second visit to this locality Oct. 20th, for the express purpose of making a more thorough search for evidence of metamorphic action. But no such evidence could be discovered, and the conclusions made after my first visit were confirmed by the second. There is no change of limestone to marble, of shales to schist, or of sandstone and conglomerate to chert. The so-called "ore" lies at or near the bottom of the Tertiary strata, just at or above their contact with the Niobrara section of the cretaceous formation. The characteristic fossils of the Niobrara rocks are abundant in the immediate vicinity, entirely unaltered by metamorphic action. Within ten rods of the Nickel Queen mine I found an unusually perfect valve of the large mollusk of the genus *Haploscapha.* Within half a mile of this mine were abundant vertebræ of the common cretaceous fish *Portheus molossus,* with occasionally a saurian vertebra. Metamorphic action such as seems necessary for the formation of valuable metallic ores would have obliterated these fossils in rocks so nearly adjacent to the ore-beds.

As bearing upon the question whether the geologist has the right to expect nickel ores in Kansas, it will be necessary to consider the location of these ores in other regions. So far as I have been able to ascertain, they occur without exception in the crystalline or metamorphic rocks, where there has been a conspicuous displacement of the strata from their original horizontal position, with evidences of their having been subjected to great pressure, and consequent high temperature. They also occur in the oldest crystalline rocks rather than in those of a later formation. Almost without exception they are located in the Archæan rocks, and without exception where the strata have been upheaved in mountain elevations. They occur in moderate quantity, in close association with chrome ores, in the serpentine rocks from Canada to Maryland. They are generally diffused throughout the magnesium rocks of the Quebec group in Canada. They are found in the serpentines of Cornwall, the Vosges and Mt. Rosa, and in the primitive schists of Norway. Mr. W. P. Blake, contributing to the volume of the U. S. Geological Survey upon the mineral resources of the United States, states that the most available ore of nickel, and the only one worked up to this date in the United States, is the sulphide, occurring in connection with the iron pyrites. This is an ore which occurs at many places along the lines of the older or Archæan rocks, being found with beds of pyrrhotite (or magnetic iron) from Canada southward. At Chatham, Conn., the nickel and cobalt ores occur in mica schist. There are small quantities of nickel at other places in ancient schists of Connecticut. The nickel ore of Thunder Bay, on the north shore of Lake Superior, is associated with native silver, and occurs in a vein traversing Huronian talcose slates.

The newly discovered deposits of nickel ore in Oregon, containing from 20 to 30 per cent. of nickel oxide, are found in serpentine with chromite and steatite. The ore of New Caledonia, averaging 18 per cent. of nickel oxide (Garnierite), occurs in veins within serpentine. The richness and abundance of these ores, and the ease with which they are smelted, has lowered the price of nickel and driven many of the poorer ores from the market.

It would therefore appear that geological considerations are unfavorable to the existence of valuable nickel ore in the State of Kansas. There are no Archæan rocks in Logan county—no crystalline rocks, and no veins containing metallic ores. The minute quantities of nickel and cobalt indicated by Professor Bailey's analysis may perhaps be accounted for by the fact that these metals, in very minute quantities, are universally disseminated over the surface of the earth, in the meteoric dust which is constantly falling through the atmosphere. According to Professor H. A. Newton, of Yale College, no less than twenty millions of meteors enter the earth's atmosphere each twenty-four hours, many of these reaching the earth's surface as the finest of meteoric dust. This dust, which like the Logan county rocks contains nickel and cobalt and iron and manganese and other chemical elements, has been found to cover the roofs of the houses of the city of Quito in South America after an unusual meteoric display. It has been found universally present in the ice and snow of the Alpine and Arctic regions. It may be collected at any time from the atmosphere by exposing to the air a properly prepared surface, as was done by Tissandier. It was dredged from the bottom of the deepest Atlantic ocean by the Challenger expedition. There is no doubt that the old Tertiary ocean of western Kansas received this meteoric dust as do the oceans of the present time. If the mud and sand and pebbles of our Atlantic should ever become hardened into rock, and form a part of the dry land, the chemists of that time would be able to detect the nickel and cobalt dust, whose meteoric origin has been established by our chemists and meteorologists. We are now applying the same test to the bottom of the old Tertiary ocean, now a part of the dry land, and find convincing evidence that then as now the atmosphere was traversed by multitudes of meteoric bodies producing the same effect as they now produce. This disintegrated meteoric matter sinking to the bottom of the ocean then as now, would be distributed by the under-currents and lodged in cavities and depressions of the ocean-bottom according to its specific gravity. Such a depression or basin seems to have been struck by the Logan county miners. But these deposits are not suitable for mining, for the quantity of nickel-dust is too small to warrant the expectation of any returns upon the money invested.

THE EVAPORATIVE POWER OF KANSAS COALS.

BY LUCIEN I. BLAKE, LAWRENCE, KANSAS.

The commercial value of coal is not a criterion of its actual heating power. The cost of mining, distance from market, competition, etc., determine the former, while the latter depends solely upon the coal *per se*. Further, the *total* amount of heat obtained by the complete combustion of a given amount of coal exceeds largely — often by fully 100 per cent. — the amount usefully obtained in practice. Confining ourselves to coal used in the production of steam, this is due to imperfect combustion, to arrangement of grate and heating surface, methods of firing, etc., etc. The same coal in different furnaces may give different results. Duty tests upon any one plant give the relative values of coals for that plant only. There is, however, an important method of comparing the actual heating values of coals which is independent of commercial values and of diversified conditions of burning. It is by measuring the heat given out by coals *under perfect combustion* expressed in terms of their evaporative powers. To this end, therefore, it is quite customary to compare coals according to their evaporative powers. By this is meant how many pounds or kilograms of water at 212° F. will be converted into steam, also at 212°, and under 760 mm. pressure, by one pound or one kilogram of coal. The object of the present investigation is to compare coals from the different Kansas veins according to their evaporative powers as defined above.

It might be mentioned that this investigation has been undertaken in conjunction with E. H. S. Bailey, Professor of Chemistry at the State University, who will make report upon the chemical analysis of the same specimens of coal. Both investigations are preliminary to a report to the State Board of Agriculture. The coals for testing have been collected personally by one or both of us at the mines. A va-